Leonard Robert Raish
Fletcher, Heald & Hildreth, PLC
1300 North 17th Street, 11th Floor
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SBC Communications, Inc.
175 E. Houston, Room 1254
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1275 Pennsylvania Ave., N.W.
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Washington, D.C. 20004

Wanda J. Sisco

HUGHES
NETWORK SYSTEMS
A HUGHES ELECTRONICS COMPANY

March 10, 1997

William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

FCC Interference Standards for WCS Auctions Contained in GN Docket No. 96-228 Are Unnecessarily Strict

Ladies and Gentlemen:

Hughes Network Systems, a business unit of General Motors Hughes Electronics, is a major supplier of cellular radio equipment and one of the driving forces behind the commercialization of the Personal Access Communications System ("PACS"). PACS itself is a low-tier, low power system standardized for operation in the 1850-1990 MHz band licensed by the FCC for broadband Personal Communications Services ("PCS").

In its Report and Order, GN Docket No. 96-228 (released February 19, 1996), the FCC amended its Rules to reallocate and assign the use of frequencies at 2305-2320 and 2345-2360 MHz, to be known as Wireless Communications Service ("WCS"). This WCS spectrum is located on either side of the 25 MHz of spectrum allocated for satellite Digital Audio Radio Service ("SDARS"). In the Report and Order, the FCC adopted technical rules to protect SDARS reception from out-of-band emissions from WCS transmitters. Simply stated, these out-of-band emission limits are much more restrictive than necessary to protect SDARS, and if allowed to stand, would effectively preclude any use of the WCS spectrum for portable communications. Based on the technical analysis outlined below, however, it would be possible for the FCC to protect SDARS from damaging interference from WCS operations while allowing for the use of specific segments of the WCS bands for portable services.

Specifically, the FCC can both afford SDARS the protection it requires and allow portable services such as PACS to operate in the WCS band by adopting the allocations and operating parameters discussed below. Table 1 describes the recommended frequency allocations for the A and B WCS bands.

Table 1.		
Band	**SU TX Frequency Range (MHz)**	**SU RX Frequency Range (MHz)**
A	2305-2310	2350-2355
B	2310-2315	2355-2360

Note that, contrary to the Commission's recommendation, the Subscriber Unit transmit allocations are at the low end of the A and B bands. The Commission had suggested making Subscriber Unit transmit at the low end of the A band and the high end of the B band to keep it as far away as possible from the SDARS receivers. Hughes objects to this plan for three reasons

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1. The additional 5MHz separation will provide only minimal additional protection since the inexpensive and physically small filters will not have adequate roll-off.
2. The "band swapping" would require significantly different RF designs for the A band and B band handsets. This will raise costs since their will be lower volumes for each type of component.
3. The Radio Ports and Subscriber Units in the A and B bands would be transmitting adjacent to each other. This will create interference between the Base Station and the Subscriber unit. .

The emissions limits in the 2320-2345 MHz SDARS band from PACS Subscriber Units and Base Stations operating in either the A or B bands as described in Table 1 are as follows:

Subscriber Unit Transmit	81 + 10 log (P) dB
Base Transmit	75 + 10 log (P) dB

Table 2 provides the technical parameters required to afford SDARS adequate protection.

Table 2. Additional Technical Parameters	
Handset Duty Cycle	12.5% Duty Cycle. 312.5 microsecond pulses every 2.5 milliseconds
SU Transmit Power	200 milliwatts
RP Transmit Power	800 milliwatts for RP at 25' height. For base stations mounted higher, it will be possible to raise the power in accordance with the additional path loss afforded by the greater distance.
Polarization	Linear

Finally, PACS in the WCS band will be restricted to offer only wireless local loop and portable services. Portable services are specifically distinguished from mobile services in that the PACS handset antenna will not be mounted on the vehicle. Rather, the handset and its transmitting antenna will be operated within 20 cm of the subscriber's head.

The technical analysis supporting these specifications can be found in the Hughes Network Systems' letter to Digivox dated January 27, 1997and is attached hereto as Exhibit A. That letter included a model of the PACS emissions, path losses between PACS and SDARS, antenna couplings, and SDARS protection requirements. As there has been no refutation of this model, we recommend that the FCC accept the out of band emissions recommendations from that letter and repeated in this letter.

Very truly yours,

Stan Kay

Stan Kay
Assistant Vice President
Hughes Network Systems

Attachments

Stanley Edward Kay

PROFESSIONAL EXPERIENCE

HUGHES NETWORK SYSTEMS
Germantown, MD

ASSISTANT VICE PRESIDENT 1990 to Present

Currently program manager on the PACS radio port, a PCS technology approved by the Joint Technical Committee and supported by Motorola, Hughes and BellCore.

System Engineering lead in HNS' entry into cellular. Developed and simulated the air interface protocols for Extended-TDMA which combines low rate speech encoding with digital speech interpolation. Provided system engineering input into the handoff algorithms and other call management procedures. HNS technical representative to the TIA and was instrumental in the development of the system capacity models used by TR45.3.4. Key system engineering role on the HNS fixed wireless telephony system. Evaluated and resolved deployment issues in mobile and fixed wireless products. Filed two individual and over 20 group patent disclosures. Gave numerous technical presentations and seminars about the HNS cellular system to potential customers in the US and in Asia.

ADVISORY ENGINEER 1985 to 1990

Responsible for performance analysis and design evaluation of new products. Develop and use software tools for analysis, modeling and simulation for product line enhancements. Among the tools used on the Personal Earth Station Product are models of a forward error correcting sequential decoder, satellite motion induced timing errors, and phase lock loops. Conducted extensive protocol and access method analysis and design for the Federal Express VSAT program. Developed system architecture for the inTELEconferencing system including a novel distributed TDMA control algorithm. Prepared system specifications on the Telephony Earth Station product and invented an overhead-free ADPCM synchronizer. Directed internal research and development projects in neural networks and wireless LANs. Made major contributions to the HNS cellular systems planning.

SENIOR PRINCIPAL ENGINEER 1984 to 1985

Lead system engineer for the architectural study of the Federal Express VSAT based ZapMail system. Study combined hardware, software and systems analysis, required 7 - 10 engineers, and culminated in optimized terrestrial and satellite resources to support the new product.

PRINCIPAL ENGINEER 1982 to 1984

Designed, modeled and simulated the acquisition and synchronization system used for the GTE SpaceNet wideband TDMA earth terminals. Instrumental in developing DAMA algorithms for M/A-COM Metropolitan Area Network product, RAPAC. Led customer funded technical feasibility study for the INMARSAT Standard-D shipboard satellite communications terminal.

SENIOR MEMBER TECHNICAL STAFF 1981 to 1982

Supporting advanced networking concepts for the NASA ACTS program in association with General Electric SSD. Analyzed performance of M/A-COM voice switch for INMARSAT shore station.

WESTINGHOUSE DEFENSE AND SPACE CENTER
Balltimore, MD

SENIOR ENGINEER 1978 to 1981

Performing communications network analysis for national air space management and naval jamming resistant systems. Supervised design and test of dynamic RAM system with error detecting and correcting codes. Specified and supervised hardware and firmware design of microprocessor based ADCCP communications controller.

PROGRAM MANAGER 1977 to 1978

Managed 12 hardware and software engineers on satellite weather data processing equipment projects.

ENGINEER 1969 to 1977

Digital design and project level responsibility for high speed satellite weather data preprocessing equipment, synchronization hardware and central control facility integration.

EDUCATION

Stevens Institute of Technology 1964 to 1969
Hoboken, N. J.
B. S. in Electronics

George Washington University 1975 to 1979
Washington D. C
M. S. in Communications.

Attended numerous in-house courses at Westinghouse in digital signal processing and logic design. Also attended continuing education seminars on CCITT X.25 Protocol and Packet Switching, Error Correcting and Detecting Codes, and Neural Networks.

Post-masters graduate courses at George Washington University in statistics and simulation and a training session in the use of SIMSCRIPT II.5.

PUBLICATIONS

Adaptive DAMA TDMA Network, T. P. Gaske, R. Gooch, S. E. Kay, A. Khalil, International Conference on Digital Satellite Communications, Pheonix, Arizona, Sept. 1983.

Technical Feasibility of Multi-channel Standard D Ship Earth Station for Advanced INMARSAT Services, S. E. Kay, E. Laborde, P. J. Freedenberg, International Conference on Satellite System for Mobile Communications and Navigation, June 1983.

An Intelligent Teleconferencing VSAT System, Stan Kay, Bob Kepley, Carl Henson, Adrian Morris, AIAA International Communication Satellite Systems Conference, March 1990.

Telephony Earth Station, Adrian Morris, Stan Kay, IEEE Global Telecommunications Conference, November 1989.

VSAT Based Videoconferencing Networks, E. R. Cacciamani, Stan Kay, Pacific Telecommunications Conference, 1990.

Digital Report Card, Stan Kay, Person-to-Person, Building Your Personal Communications Future, October 1992.

E-TDMA, Stan Kay, Cellular Business, June 1992

Extended-TDMA, A High Capacity Evolution of US Digital Cellular, ICUPC, October 1992

E-TDMA: High Capacity Digital Cellular Radio, ICC, June 1992

Wireless Access Communications Systems for PCS/AIN Applications, WCF94, February 8, 1994

Two-tier Scheme Yields High Mobility, America's NETWORK, August 15, 1994

CORPORATE AWARDS

Presidential Award for Excellence in the Field of Technology, 1991

Telecommunications and Space Sector Patent Award, 1993

PATENT AWARDS

STABILIZED TELEPHONY COMBINER, 5,276,409, JANUARY 4, 1994.

METHOD AND APPARATUS FOR EXPLOITATION OF VOICE INACTIVITY TO INCREASE THE CAPACITY OF A TIME DIVISION MULTIPLE ACCESS RADIO COMMUNICATIONS SYSTEM, 5,299,198, MARCH 29, 1994

CHANNEL COMPRESSION AND DYNAMIC REPARTITIONING FOR DUAL MODE CELLULAR RADIO, 5,343,513, AUGUST 30, 1994

TRANSMISSION POWER LEVEL ADJUSTMENT IN RADIO TELEPHONY, 5,357,513, OCTOBER 18, 1994

CELLULAR SYSTEM HAVING FREQUENCY PLAN AND CELL LAYOUT WITH REDUCED COCHANNEL INTERFERENCE, 5,365,571, NOVEMBER 15, 1994

SEQUENTIAL POWER ESTIMATION FOR CELLULAR SYSTEM HANDOFF, 5,367,559, NOVEMBER 22, 1994

VESTIGIAL IDENTIFICATION OF COCHANNEL INTERFERENCE IN CELLULAR COMMUNICATIONS, 5,390,197, FEB 14, 1995

TDMA SYNCHRONIZATION USING VISIBILITY DESIGNATION, 5,315,589, MAY 24, 1995

CHANNEL COMPRESSION AND DYNAMIC REPARTITIONING FOR DUAL MODE CELLULAR RADIO, 5,422,932, JUNE 6, 1995

METHOD AND SYSTEM FOR EFFECTING HANDOFF IN A CELLULAR COMMUNICATION SYSTEM, 5,422,933 JUNE 6, 1995

METHOD FOR EXPLOITATION OF VOICE INACTIVITY TO INCREASE THE CAPACITY OF A TIME DIVISION MULTIPLE ACCESS RADIO COMMUNICATIONS SYSTEM, 5,513,183, APRIL 30, 1996

DYNAMIC THRESHOLDING FOR MOBILE ASSISTED HANDOFF IN A DIGITAL CELLULAR RADIO SYSTEM, 5,483,669, JANUARY 9, 1996

CELLULAR TELEPHONE WITH DATAGRAM AND DISPATCH OPERATION, 5,475,689, DECEMBER 12, 1995

OTHER PROFESSIONAL ACTIVITIES

Represented M/A-COM on the IEEE 802.5 Metropolitan Area Networks Committee and represented HNS on the IEEE 802.4L Radio-LAN subcommittee. Represented HNS on the Telecommunications Industry Association's TR45.3 Standards Committees.

Member IEEE and IEEE Communications Society

Co-developed and taught a successful semiannual George Washington University Continuing Education Department course on Satellite Communications: *System Planning, Design and Operation at K_u and K_a Bands*

EXHIBIT A

HUGHES
NETWORK SYSTEMS
A HUGHES ELECTRONICS COMPANY

January 27, 1997

John Prawat
President and CEO
DigiVox Corporation
P.O. box 65094
Washington, DC 20035

Dear John:

Hughes Network Systems (HNS), a business unit of General Motors Hughes Electronics, is a major supplier of cellular radio equipment and one of the driving forces behind the commercialization of the Personal Access Communications System (PACS). The Commission's Rules to Establish Part 27 offer potential bands for PACS technology if the interference into SDARS proves manageable.

In our 22 January letter to you we used the allowable interference noise energy of -137.9 dBW/MHz proposed in the 13 January Lucent Supplemental Technical Statement of Lucent Technologies Inc.. We had mistakenly assumed from Lucent's statement "After technical discussion with Primosphere Limited Partnership we agree that the WCS spectrum with SDARS in the middle of the band is unique...", to mean that Lucent and Primosphere had reached agreement on the parameters to use in the analysis.

After subsequent review, we agree with Primosphere that Lucent's assumption of 2000°K receiver noise temperature is unrealistic. On the other hand, we feel that Primosphere has failed to provide adequate justification for their claimed noise floor of 200°K. HNS is the leading manufacturer of Very Small Aperture Terminals (VSAT) and understands the noise floor behavior of satellite terminals. While 200°K is a reasonable number for VSAT and other satellite communications terminals with narrow beam antennas pointed to cold sky in C-Band and Ku-Band applications, we question its legitimacy for a 2.35 GHz, car-mounted antenna for the following reasons:

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1. The VSAT antenna does not pick up significant terrestrial emissions because there is minimal spurious noise generated at K_u Band and because the antenna points towards 0°K space. In contrast, the side lobes of the SDARs antenna will see a variety of terrestrial sources. The 2.35 GHz band is near the 2.4 GHz ISM band in which most microwave ovens operate. Interference may also come from harmonics of the 450 MHz band terrestrial mobile radio and UHF broadcast channels 64 and 65. In addition to potential signal emissions, the temperature of the people, buildings, trees, car ignitions, etc., in the antenna pattern will be much warmer than outer space. For this reason HNS suggests adding an ambient temperature of at least 290°K to the LNA noise temperature.

2. A C Band or K_u Band LNA uses a waveguide front end with very low loss. The SDARS receiver must reject the A, B, C, D, E and F bands. HNS estimates that this would require a filter ahead of the LNA with an insertion loss close to 2 dB. This is because the SDARS equipment receiver response must roll off before entering the neighboring WCS channels to prevent a signal from a WLL base or mobile station into the front end LNA.

3. Primosphere correctly states that the LNA Noise Figure may be 1 dB. A typical receiver noise figure, however, degrades as the signal passes through mixers, filters, etc., and for low cost design can closer to 2dB.

Based on the above, HNS estimates the effective noise floor at the receiver as follows

Thermal Noise	-168.6	dBW/MHz	
80° K LNA + 290° K Environment	26	dB	It may be worse than this when terrestrial sources are nearby
Filter Insertion Loss	2	dB	To reject bands A,B,C,D,E and F
Post LNA Contributions	1	dB	Mixer, Amplifiers, etc., following LNA
HNS "Worst Case" Scenario	-139.6	dBW/MHz	
Primosphere claim	-145.6	dBW/MHz	
Split the difference	-142.6	dBW/MHz	Used for the rest of this letter

HNS suggests a compromise noise floor between the excessively optimistic Primosphere value of -145.6 dBW/MHz and the non-optimal design configuration described by HNS resulting in -139.6 dBW/MHz. HNS believes that the FCC should require Primosphere to offer evidence that -145.6 dBW/MHz is their actual noise floor. For the remainder of this letter, HNS assumes a noise floor of -142.6 dBW/MHz.

Primosphere should also demonstrate the accuracy of their claims in two other areas, the antenna pattern and the allowable noise rise.

The antenna plays a critical role in the analysis. HNS assumes that the antenna is some sort of a flat panel antenna mounted on the roof of the vehicle. The metallic floor and the car body will prevent the antenna pattern from being omnidirectional. If the PACS handset is in a vehicle or at street level, it may not be in the main beam of the Primosphere antenna. Also, the vertical polarization of the PACS signal will interact in an unknown way at the beam edge of the circularly polarized Primosphere antenna. HNS will use 3 dB main beam antenna gain for the Primosphere antenna, but include 6 dB of side lobe loss and another 3 dB of protection for linear polarization.

Allowable noise rise normally depends on the system margins. The typical fixed K_u Band VSAT application only needs rain fade margin. For SDARS, HNS expects that the largest need for margin would be for shadowing from buildings in urban areas. Primosphere should have included margin on the order of 6-10 dB for building shadowing. For the rural case there is less building shadowing, but HNS argues that the chance of a handset being very near an SDARS receiver in the rural environment is small. Both urban and rural environments should include 3-6 dB margin for Ricean fading. In such highly variable propagation environment, HNS argues that it is unreasonable to limit the noise floor rise from WCS to 0.2 dB. Even a noise floor rise of 2 dB is very generous because the handset contribution really should be combined in a root-sum-squared (RSS) manner with the shadowing and fading variances. Using -142.6 dBW/MHz as the noise floor and allowing a 2 dB rise, means an allowable interference level of -144.9 dBW/MHz for PACS.

HNS wishes to make one other point before presenting the link budgets. Since the A/E and B/F bands are spaced 5 MHz from the SDARS band, the PACS signal energy will be in the transmitter noise floor. The design constraint is controlling the broadband noise emissions. The typical design of the transmitter is a mixer from roughly a 300 MHz IF to the 2.3 GHz transmit band followed by a power amplifier. The noise floor comes from

1. *Noise entering the final mixer stage*. A SAW filter at the final IF can reduce this noise at 5 MHz from the band edge
2. *Final mixer noise figure*. Commercially available parts provide a noise figure of 10 dB.
3. *Oscillator phase noise from the final mixer stage*. Handset compatible frequency sources (reasonably priced, small, low power) will have significant phase noise energy at 5 MHz from the carrier. Since the output of the final mixer is in the transmit band, the filter Q to achieve meaningful attenuation from 2315 and 2320 MHz is unreasonable.
4. *Gain of the power amplifier*.. The final amplifier stage will amplify the noise at its input. To control this, one could use a high gain mixer to reduce the gain requirements of the final stage. These components are relatively expensive.
5. *Final amplifier noise figure*. Commercial amplifiers will have roughly a 10 dB noise figure in this band and at these powers.

Assuming an amplifier noise figure of 10 dB, a high power mixer with a -10 dBm output and a final amplifier gain of 33 dB, the noise input at the power amplifier must be -124 dBW/MHz. HNS contends that even the best known handset layout, packaging, and shielding techniques cannot do better than this due to the close proximity of the digital signal processing and the fluctuations of the power circuitry. Furthermore, HNS notes that four of the five techniques suggested by Primosphere's January *13 Ex Parte* filing are being used by HNS to suppress the broadband noise, i.e., frequency planning, spectrum shaping, filtering and cross polarization. The fifth technique, amplifier backoff, is irrelevant in suppressing broadband noise.

The above assumptions result in the link analysis given in Table 1.

Table 1. Proposed Reverse Direction Link Budget			
Handset Noise Floor	- 81.0	dBW/MHz	Broadband Noise is the limiting factor
Handset Duty Cycle	- 9.0	dB	12.5% Duty Cycle. 312.5 usec pulses every 2.5 msec
Min Path Loss	-51.0	dB	12 foot separation is more realistic in vehicular traffic
SDARS Ant. Gain	3.0	dB	Per Primosphere filings
Head Loss	-5.0	dB	3 to 15 dB typical for energy absorbed by human head
SDARS Beam Shape	- 6.0	dB	Hemispheric beam pointing up gives loss of at least 6dB for typical PACS handset location in traffic
Polarization Loss	- 3.0	dB	Circular to linear polarization decoupling
Total	-152.0	dBW/MHz	
Interference Allowed	-144.9	dBW/MHz	
Margin	7.1	dB	PACS provides more than the needed margin

For the forward link, PACS base stations will be mounted as low as 25 feet or as high as 100 feet. At the 25 foot height, the base station transmitter will be limited to 800 mw which is 6 dB more power than the handset. The additional gain required in the final amplifier stages will raise the noise floor by 6 dB. Table 2 shows that these assumptions provide 1.1 dB of margin in the forward direction. For base stations mounted higher, it will be possible to raise the power in accordance with the additional path loss afforded by the greater distance.

Table 2. Proposed Forward Direction Link Budget			
Base station Noise Floor	- 75.0	dBW/MHz	Broadband Noise is the limiting factor
Min Path Loss	-57.0	dB	24 foot separation for handset directly under base station
Base antenna Gain	6	dB	Omnidirectional stacked dipole
Directivity below base station	-20	dB	Dipole has very low gain below and above antenna
SDARS Ant. Gain	3.0	dB	Per Primosphere filings
Polarization Loss	- 3.0	dB	Circular to linear polarization decoupling
Total	-146.0	dBW/MHz	
Interference Allowed	-144.9	dBW/MHz	
Margin	1.1	dB	PACS provides more than the needed margin

HNS could evaluate other for the handset being in the antenna main lobe. The typical vertical beamwidth for a 6 dBd antenna is 10-20°. For the handset to be in the main beam it will be far enough from the base station so as not to pose a problem.

Sincerely,

Stan Kay

Stan Kay
Assistant Vice President
Hughes Network Systems

B

Bellcore

Bell Communications Research

From: RC Mulkemes
Director, Radio Techniques and Technology
Bellcore
331 Newmans Spring Rd.
Redbank, NJ, 07701
908-758-3357

Date: March 6, 1997

To: Dr. R. White
President, PACS Provider Forum
445 South Str.
Morristown, NJ 07960

Re: WCS Out-of-band emissions limits should be modified for PACS

Dear Dr. White,

Bellcore has performed a technical analysis of the WCS rules in GN No. 96-228 adopted February 19, 1997. These rules, in part, address the impact of WCS services on other spectrum users and appropriately impose interference limits to protect these users. However, the portion of the rules dealing with out-of-band emissions limits from the WCS bands into the SDARS spectrum band are unnecessarily stringent for a low-power, low mobility technology such as PACS. These limits are designed to accommodate higher power, wide-area mobility wireless technologies and are therefore overly restrictive of PACS. Bellcore believes PACS should be considered separately with respect to the application of out-of-band emissions limits. Bellcore also believes that the SDARS service will not be adversely affected by modifying the rules for out-of-band emissions limits for PACS as discussed below. Therefore, it is desirable and appropriate to modify the WCS rules dealing with out of band emissions associated with PACS.

An out of band emissions limit of 81 dB for the Subscriber Unit, SU, and 75 dB for the Radio Port, RP, will provide a suitable environment for both PACS wireless users in the bands from 2305 MHz to 2315 MHz and from 2350 MHz to 2360 MHz and will provide sufficient margin for SDARS users in the 2320 MHz to 2345 MHz band to operate without interference. The PACS technology limits the RF output power of the SU and RP to 200 mw and 800 mw, respectively. PACS SU transmitters are operated on a 12.55% duty cycle basis thus averaging the potential for interference over the 2.5ms frame period allowing forward error correction and block interleaving techniques to be used effectively to reduce interference in other services.

Arguments made by Hughes Nctwork Systems, dated January 22, 1997 and Fcbruary 5, 1997, correctly state that PACS uses a number of interference abatement tcchniques such as Raised Root Cosine modulation filtcring, transmit spectrum filtering and dynamic power control with quasi linear RF powcr amplifier output to control out of band cmissions.

Path loss factors, antenna directivity and polarization effects add substantially to the overall signal attenuation and the reduction of intcrference. Free space path loss in this frequency band is nearly 51 dB while antenna factors such as polarization decoupling, SDARS antenna bcam shape and the PACS SU antenna pattern will add another 9 to 12 dB of additional isolation. Head loss can add, on averagc, another 3 to 15 dB of path loss to the overall path loss budgct.

Finally, as stated earlier, PACS uscs adaptive power control ovcr a 30 dB range to continuously lower the SU's output power to thc lowest possible transmitter power levels to reducc system interference thereby minimizing the interference to other scrvices as well.

Respectfully yours,

RC Malkcmcs
Director Radio Techniques and Technology

cc:
H W Sherry

C

Statistical Analysis of Potential Interference with SDARS from Mobile WCS Operations

March 7, 1997

Ronald M. Harstad, Ph.D.

Associate Professor of Economics, Rutgers University

GN Docket No. 96-228

The Report and Order promulgating rules for the WCS auction, seeks to ensure that mobile uses of WCS bands do not interfere with Satellite Digital Audio Radio Services (SDARS) operations contemplated in the 2320-2345 MHz range. Suppose this goal is accepted without debate. It is nonetheless true that the rules overzealously pursue this goal, setting interference standards so restrictive as to prevent usage in WCS A and B blocks of even the lowest-power technologies available to offer mobile services. ***No reasonable purpose is served by such restrictive standards.***

Hughes Network Systems (HNS) has submitted reports in this docket suggesting reasonable interference standards which still permit some mobile technologies.[1] This memo indicates that the level of protection of SDARS under HNS standards is extraordinarily high: ***for these sensible standards, interference with SDARS signals from WCS handsets is such a rare occurrence as to be completely indiscernible*** amidst interference that arise unavoidably from other sources.[2]

The Appendix to this memo presents results and relevant parameters from a statistical model designed to estimate the frequency with which WCS handsets would be transmitting within a short enough distance from an SDARS antenna as to create the possibility of interfering with the SDARS signal; the number of seconds of such interference is also estimated.

How rarely WCS handsets might interfere, and how brief any interferences might be,[3] depends upon about three dozen parameters, ranging from such obvious and fundamental determinants as the extent of WCS market penetration, and the average number of minutes of usage per month, to such more subtle parameters as the pace of a pedestrian walking along conversing on a handset, or how often a driver listening to SDARS prefers to stay out of the curb lane, to proceed more smoothly.

Some parameters are not known with much precision. Hence, for each parameter, I have used two numbers, one "Unfavorable" in that it makes interference more likely, the other "Favorable" to the claim that interference will be a rare event. The attempt is to incorporate numbers so that poorly known parameters are likely to fall somewhere between the two.

Simply put, the chances of interference with SDARS under the sensible HNS standards range from very remote to inconceivably small. ***Even when every parameter is set to its unfavorable level, interference is still a strikingly remote event.***

---

[1] These standards include emissions limits in the SDARS band from Subscriber Units and Base Stations operating in either the A or B WCS bands of 81 + 10 log (P) dB for Subscriber Unit Transmit and 75 + 10 log (P) dB for Base Transmit. In addition, the HSN standards include: linear polarization, SU Transmit Power limited to 200 milliwatts, RP Transmit Power standardized at 25 feet above surface to no more than 800 milliwatts, and a 12.5% Handset Duty Cycle at 312.5 msec pulsing every 2.5 msec. The estimates presented here, even for favorable parameters, are conservative in that the 12.5% duty cycle is ignored.

[2] Specifically, this interference from trees and buildings can only be prevented by siting and installing a network of ground repeaters; these same ground repeaters serve, within the scope set by their wattage, to overcome WCS interference as well as that from trees and buildings.

[3] Interferences lasting less than 1 second are ignored throughout, though this makes little difference to the results

Three principal situations are considered. The first is designed to stylize a congested urban area, like that of the central business district and nearby densely populated residential areas that occur in most large cities in the Eastern U.S. Automobile and pedestrian traffic are both dense, and broad sidewalks typically stretch from buildings to the curb. This setting creates the most potential for SDARS interference from buildings as well as from WCS handsets. The second represents a more moderate degree of urban congestion, like that in the center of newer cities in the Western U.S., as well as near-in suburbs of major metropolitan areas throughout the country. Tall buildings are rarer, but so is pedestrian traffic. The third scenario directly considers traffic on an urban expressway.

Both the probabilities of WCS interference, and the total number of seconds of such interference, per trip made by a driver listening to SDARS, are such small numbers as to be hard to comprehend. Let me convert them into descriptions of how much driving an SDARS listener can expect to do between occurrences of WCS interference. The results are in the table on the next page. (The notation #N/A indicates a number too large for Excel to display in scientific notation.)

Here are a few examples of how these numbers are interpreted. Suppose someone is listening to SDARS while driving along an urban expressway. Then, for favorable parameter values, that driver will find SDARS reception interfered by a WCS handset *once every 250,000 miles*--for most of us, this means ***less than once in a lifetime***. In terms of time spent driving on the expressway, *for every second* when WCS interferes with reception, there are on average nearly ***12 million seconds*** when reception is either clear, or prevented by some technological factor beyond the control of the FCC, not by WCS. These astronomical numbers actually have a conservative bent, in that they assume interference actually occurs whenever physical proximity might make interference possible. Numbers this large stem from several favorable but reasonable assumptions about urban expressway driving, such as a traffic density of 90 vehicles per mile per lane. However, even when every parameter is switched from favorable to unfavorable, WCS interference on expressways remains remote: it happens on average once every 375 miles, with duration totaling 1 second in every 22,000. This means that a commuter with a 70-minute commute will have his/her SDARS signal interfered with by WCS handsets less then 1 second per week.

Neither all parameters being that unfavorable or all parameters being that favorable is at all likely. The odds are very high, though, that parameters are sufficiently removed from the all-unfavorable levels to limit WCS interference to ***less than 3 seconds per year*** for the average commuter listening to SDARS.[4] **This is the level of interference that the FCC inexplicably decided was insufficient protection for SDARS**!

[4]As a combination of the two extremes, this puts about a 97% weight on the unfavorable case, and a 3% weight on the favorable one.

Statical Estimates Indicate that WCS Interference with SDARS Is Extremely Rare

		Eastern City Center		Western City		On Expressway	
		Unfavorable	Favorable	Unfavorable	Favorable	Unfavorable	Favorable
Average Miles of Uninterfered Driving,: Between Occurrences of Interference from:	WCS Handset in Moving Vehicle	588	371,186	325	195,536	374	259,556
	Pedestrian Using WCS	28.0	#N/A	#N/A	#N/A		
Average Number of Seconds of Driving,: For Each Second of Interference from:	WCS Handset in Moving Vehicle	125,022	35,867,006	29,900	14,104,334	22,231	11,854,256
	Pedestrian Using WCS	11,633	#N/A	#N/A	#N/A		

Interference due to WCS transmissions from moving vehicles is almost as remote an event for an SDARS driver on local streets in a Western city or Eastern near-in suburbs: once every 195,000 miles for favorable parameters, or once every 325 miles for completely unfavorable parameters. Somewhere between these two scenarios, it is not very likely that a driver listening to SDARS in areas with this level of congestion will face WCS interference more than 2-3 times per year. Moreover, these rare interferences will be of even shorter duration than those occurring on expressways (because drivers talking on handsets are often traveling further below average traffic speed on suburban roads than on expressways, among other reasons); the 14 million number translates into 1 second's interference about every 4,000 hours of driving. The #N/A appearing under the Western city headings means that interference with SDARS reception due to pedestrian-held WCS handsets is absolutely no worry: before it happens twice, all land-based means of transportation will likely be obsolete.

The high level of congestion characteristic of central cores of large Eastern-U.S. cites creates the greatest frequency of proximity between WCS handsets and SDARS antennas. However, this is also where interference from buildings will force SDARS providers to install a considerable network of ground repeaters to have any hope of commercially feasible reception. In ex parte discussions with the FCC on March 5, 1997, Primosphere engineer Richard Cooperman stated that Primosphere is not yet ready to talk about the density with which these repeaters will be needed, or the wattage likely to be effective. Hence, we have had to guess more or less blindly at these parameters; the results appear not to be very sensitive to these particular assumptions.

Vehicular interference from WCS on congested urban streets that is not rendered moot by SDARS ground repeaters is clearly an order of magnitude less likely than on expressways; we should live so long. Congested urban areas are the only place where the impact on SDARS reception of WCS-using pedestrians might even be measurable, and even then only when most of the conditions come very close to the unfavorable parameters. The results show that, under about the worst of circumstances, a driver downtown in a megalopolis will detect interference that is due to WCS pedestrians once every 28 miles. This translates into about once in every half-dozen fares for a Manhattan cabdriver; under less dramatically unfavorable conditions, probably less than once in a couple hundred fares. In terms of the duration of pedestrian-WCS interference in urban areas, 1 second of interference every 11,600 seconds means about a second every 200 minutes. Less extreme parameters could easily reduce this likelihood by a factor of 1,000 or more.

All these results treat 12 feet as enough distance to prevent interference; this is one of the few parameters with a quadratic rather than linear impact on the calculations. Even here, though, the results are quite robust. If this number were way off, and a 15 foot distance from WCS handset to SDARS antenna were needed to ensure no interference, none of the results decrease by an order of magnitude. Pedestrian interference is still only an issue in Eastern city centers and still only under unfavorable conditions, and a driver would then be able to drive over 16 miles between pedestrian-WCS interference occurrences, and have over 5,300 seconds of clear reception for each second of WCS interference. The biggest change would be to cut the number of seconds between expressway interferences about in half, to 1 second out of every 9,376, still an abundance of protection for SDARS.

Another way to put these small numbers in context is to compare them with the frequency of interference from trees and large buildings. The *Report of the Field Test Task Group; Field Test Data Collection and Presentation*, an independent industry task force considering such interference, concluded that, for the 2320-2345 MHz band, "In major urban areas, S-band system failure rate exceeded 90%." This leads to my original characterization that WCS interference would be completely indiscernible. In terms of the number of seconds of interference for an urban driver listening to SDARS, ***trees and buildings*** *will cause* ***between 9,600 times*** *(under unfavorable parameters!)* ***and 32,000,000 times*** *(favorable)* ***as much interference as WCS transmissions****, mobile and pedestrian combined.* Even if the Field Test Task Group has vastly overestimated the SDARS failure rate, and it is only 45%, that only halves these extremely high ratios of the causes of interference. Whatever the precise parameters, it seems clear that the interference which cannot be outlawed is at least one million times as likely as the WCS interference the FCC is unreasonably trying to outlaw.

	Direction of Bias in Estimating Parameters:	Unfavorable	Favorable	Unfavorable	Favorable	Unfavorable	Favorable
	Situation Being Modeled:	Dense, City	Eastern Center	Western	City, or Suburbs	Along Expressway	
	Results:						
	Miles of Driving, Listening to DARS, per Event of:						
	Interference due to use of WCS in a vehicle:	588	371,186	325	195,536	374	259,556
	Interference due to Pedestrian use of WCS:	28.0	#N/A	#N/A	#N/A		
	Seconds of Driving, Tuned to DARS, per Second of:						
	Interference due to use of WCS in a vehicle:	125,022	35,867,006	29,900	14,104,334	22,231	11,854,256
	Interference due to Pedestrian use of WCS:	11,633	#N/A	#N/A	#N/A		
	Avg Number of Seconds of Interference from Trees	(0.90)	(0.90)	(0.80)	(0.80)	(0.60)	(0.60)
	& Bldgs, per Second of Interference from WCS:	9,578	32,280,305	8,514	28,693,605	6,386	21,520,203
	Key Parameters:						
1	WCS Market Penetration:	10.0%	3.0%	10.0%	3.0%	10.0%	3.0%
2	Average WCS Usage, in minutes/month	800	200	800	200	800	200
3	Average Number, SDARS Ground Repeaters, per road mile	1.5	3	0.6	1	0.4	1.5
4	Average Gound Repeater Coverage, in linear miles of road	0.17	0.25	0.2	0.3	0.2	0.25
	Average distance, WCS handset to SDARS antenna:						
5	--Sufficient to Assure Against Interference, in feet	12	12	12	12	12	12
6	--When WCS vehicle 1 lane to the left of SDARS vehicle	10.9	11.5	11.5	11.8	11.5	11.8
7	--When WCS vehicle 1 lane to the right of SDARS vehicle	9.1	10.2	9.5	10.5	9.2	10.5
	When SDARS Vehicle Is in the Curb Lane,						
8	Average Distance from Antenna to Curb, in feet	4.6	6	7	10.5		
9	Distance from Antenna to Pedestrian Walking in Road, feet	6.5	8	8	10		
10	Average Vehicle Density, per mile, per lane of road	230	120	170	80	200	90
11	Average Number Lanes in 1 Direction, per road	2	2.5	2.2	2.7	2.8	3.6
12	Average Vehicular Speed, in miles per hour	10	30	28	42	40	60
13	Average Pedestrian Speed, in feet per second	5	4	5.5	4.5		
	Average Pedestrian density, per linear mile:						
14	--One Side of Road, where there is a sidewalk	200	50	20	6		
15	--One Side of Road, where there is no sidewalk	20	4	4	1		
16	Average Width of Sidewalk, in feet, where it exists	8	14	3.6	4.2		
	The Following Parameters Are in Percentages:						
17	WCS Minutes Transmitted from Moving Vehicle	15%	5%	15%	5%	15%	5%